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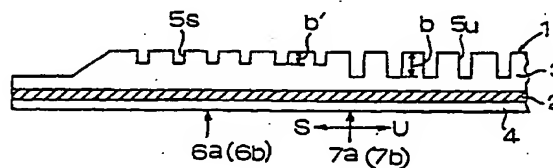
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(54) Belt for shoe press

(57) A belt (1) for a shoe press with felt side resin layer (3) grooves (5) having improved crack resistance in the vicinity of a shoe edge has the grooves (5) in that vicinity of a reduced depth, increased pitch or both. In a first embodiment, the depth (b') of the recessed grooves (5s) in the portion of the felt side resin layer outside of the width of a paper sheet to be made, i.e., the outside grooves, is shallower than the depth (b) of the recessed grooves (5u) in the portion of the layer which is inside of the width of the paper sheet, i.e., the inside grooves. In a second embodiment, the depth of the outside grooves (5s) diminishes stepwise toward the outside from the edge of the paper. In a third embodiment, the pitch (c'), or widthwise spacing, of the outside grooves is greater than the pitch (c) of the inside grooves and each outside groove is one-half of the depth of the inside grooves. In a fourth embodiment, the outside grooves are of both increased pitch and stepwise diminishing depth.

FIG. 1



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## Description

## BACKGROUND OF THE INVENTION

5 The present invention relates to a belt for a shoe press which is provided with grooves made in the resin layer on the surface of the felt side of a belt body so as to increase the performance of squeezing water from a wet paper sheet and a felt in the press portion of a paper making machine.

In general, there are two types of belts for a shoe press: (1) a flat smooth belt formed of a base cloth and a resin layer formed on the inner surface of the base cloth or resin layers formed on both surfaces of the base cloth; and (2) a  
10 grooved belt which has resin layers on both surfaces of the base cloth and whose felt side resin layer is provided with recessed grooves ("grooves" includes both continuous grooves and single grooves; recessed single grooves are also referred to as recessed holes) so as to squeeze water.

In this respect, as shown in FIG. 5, the belt body 1 of the latter belt has on both surfaces of the base cloth 2 resin layers 3 and 4, which are impregnated with resin or are coated with resin, and recessed grooves 5 (continuous or single)  
15 for squeezing water are formed in the resin layer 3 of a felt side thereof.

The above-described grooved belt has a great effect on the squeezing of water by the action of the recessed grooves 5 formed in the resin layer of the felt side and has been widely used in recent years. Although the specific sizes of the recessed grooves 5, such as width of groove (or if a round hole, the diameter of the hole) (a), depth of groove (or depth of hole) (b) and pitch of groove (or pitch of hole) (c), are determined in agreement with the type of a paper sheet  
20 to be made or the machine conditions of a user, as matters now stand, they are the same across the whole width of the belt in one belt and are uniformly formed as a whole.

However, as shown in FIG. 6, when the belt 1 is used in the press part 6 of a paper making machine, the strain and the load applied to the belt 1 are not uniform across the width thereof. This is because the load tends to be applied to the parts corresponding to the shoe edge portions 6a and 6b, where spots of pressure caused by the step of the wet  
25 paper sheet 7, the step of the felt 8 and deformation or squeezing load at the shoe edge portions 6a and 6b are increased. Thus, the load on the belt is higher in the portions (S) which are outside of the width of the paper sheet 7 (including the shoe edges 6a and 6b) in comparison with the portion U which is inside of the edges 7a and 7b of the wet paper sheet, where the wet paper sheet 7 and the felt 8 are uniformly squeezed.

In particular, since the ear portions of the belt are fixed by side rings 9 and 9 in a closed type shoe press, a shearing force and a strain applied to these portions are increased and hence the belt tends to be damaged. Thus, while the belt is used, cracks tend to be produced in the recessed grooves 5 made in the parts corresponding to the shoe edges of the belt body.

A belt having cracks at some portions is replaced even if it has no wear nor cracks at other portions, which is uneconomical. Therefore, a technique for improving crack resistance has been sought in recent years.

For example, it has been proposed to improve the crack resistance of the belt by reducing the hardness of the resin.  
35 However, the problem with this idea is that wear resistance and deformation resistance to pressure, which are the important properties of the belt for the shoe press, cannot be maintained with softer resins. Also, the shape of the groove is harder to maintain under pressure with softer resins.

It has also been proposed that crack resistance can be improved by changing the base cloth or the resin constitution of the belt, but this would require an improvement in the presently used papermaking technique and equipment,  
40 which results in spending much time and cost.

It is therefore an object of the present invention to provide a belt for a shoe press having grooves with improved crack resistance in the vicinity of the shoe edges, using the presently used papermaking techniques and equipment, without deteriorating the function of the belt.

## BRIEF SUMMARY OF THE INVENTION

To accomplish the above-described object, according to one aspect of the present invention, a belt for a shoe press having recessed grooves in the resin layer on the felt side surface of the belt body is constituted such that the depth of  
50 the recessed groove in the portion of the belt body outside the width of a paper sheet to be made is made shallower than the depth of the recessed groove in the portion inside the width of the paper sheet to be made, whereby the strength of the recessed grooves in the vicinity of a shoe edge portion is increased and crack resistance can be improved.

In an especially useful form of the present invention, the depth of the recessed groove in the above-described portion of the belt body outside the width of the paper sheet to be made is made about half of the depth of the recessed groove in the portion inside the width of the paper sheet to be made, so that the strength thereof is not reduced while keeping the performance of squeezing water.

Further, in another useful form, the depth of the recessed groove in the above-described portion of the belt body

outside the width of a paper sheet to be made is made gradually shallower toward the outside from the edge of the wet paper sheet, whereby the strength of the belt at the belt edge side in which the required performance of squeezing water is little is not reduced.

In another aspect, a belt for a shoe press having recessed grooves in the resin layer on the felt-facing side surface of a belt body is constituted such that the pitch of the recessed grooves in the portion of the belt body outside the width of a paper sheet to be made is made wider than the pitch of the recessed grooves in the portion inside the width of the paper sheet to be made, whereby the number of the recessed grooves is made smaller in the vicinity of the shoe edge.

These and other aspects and advantages of the invention will be apparent from the drawings and detailed description.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial sectional view in the direction of the width which shows a main portion of a belt in accordance with the present invention, wherein the depth of recessed grooves in a portion outside the width of a paper sheet to be made is made about half of the depth of recessed grooves in a portion inside the width of the paper sheet to be made;

FIG. 2 is a partial sectional view in the direction of the width which shows a main portion of a belt in accordance with the present invention, wherein the depth of recessed grooves in a portion outside the width of a paper sheet to be made is made progressively shallower toward the outside from the edge of the paper sheet to be made;

FIG. 3 is a partial sectional view in the direction of the width which shows a main portion of a belt in accordance with the present invention, wherein the pitch of the depth of recessed grooves in a portion outside the width of a paper sheet to be made is made wider than the pitch of recessed grooves in a portion inside the width of a paper sheet to be made;

FIG. 4 is a partial sectional view in the direction of the width which shows a main portion of a belt in accordance with the present invention, wherein the pitch of the recessed grooves in a portion outside the width of a paper sheet to be made is made wider than the pitch of the recessed grooves in a portion inside the width of a paper sheet to be made and the depth of the recessed grooves in a portion outside the width of a paper sheet is made progressively shallower toward the outside from the edge of the paper sheet to be made;

FIG. 5 is a sectional view in the direction of the width which shows a main portion of a belt of conventional type; and

FIG. 6 shows a pressing portion of a paper making machine.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings, a belt body 1 has on both surfaces of a base cloth 2 the resin layers 3 and 4 which are impregnated with resin or are coated with resin and recessed grooves 5 for squeezing water are made in the resin layer 3 of a felt side thereof, which is so denominated since it faces felt 8 (Fig. 6).

The recessed grooves 5 may be continuous grooves or single grooves (also referred to herein as recessed holes) arranged in a plane. In the belt according to the present invention, as shown in FIG. 1, the depth (b') of the recessed grooves 5s of the belt body 1 in the portion outside the edges 7a, 7b (7b is on the other side as shown in Fig. 6) of the wet paper sheet. That is, the portion (S) outside the width of the paper sheet to be made is made shallower than the depth (b) of the recessed grooves 5u in the portion (U) inside the width of paper sheet to be made. To be more specific, the depth 5b, of the recessed grooves 5s is made about half of the depth (b) of the recessed grooves 5u, whereby the strength of the recessed grooves in the vicinity of the shoe edge portions 6a, 6b is not reduced.

In another embodiment of a belt according to the present invention, as shown in FIG. 2, the depth (b') of the recessed grooves 5s of the belt body 1 in the portion outside the edges 7a, 7b of the wet paper sheet, that is, in the portion (S) outside the width of the paper sheet to be made is made gradually (progressively stepwise) shallower toward the outside from the wet paper sheet and the recessed grooves are eliminated at the edge of the belt. In this respect, it is taken into account that the depth of the recessed grooves 5s is not dramatically changed at the boundary of the edges 7a, 7b of the wet paper sheet and that the strength of the belt at the belt side edges is not reduced.

In a third embodiment of a belt according to the present invention, as shown in FIG. 3, the pitch (c) of the recessed grooves 5s of the belt body 1 in the portion outside the edges 7a, 7b of the wet paper sheet, that is, the portion (S) outside the width of the paper sheet to be made, is made wider than the pitch (c) of the recessed grooves 5u in the portion (U) inside the width of the paper sheet to be made. In this respect, as shown in FIG. 4, the depth (b') of the recessed grooves 5s may be common to the depth of the recessed grooves 5u but, as shown in FIG. 4, it is needless to say that the depth (b') of the recessed grooves 5s may be made gradually (progressively stepwise) shallower toward the outside from the edges 7a, 7b of the wet paper sheet.

The above-described recessed grooves 5 are required to have sufficient void volume f for holding and discharging water squeezed from the wet paper sheet and the felt. However, this is true for the recessed grooves 5u in the portion

(U) inside the width of paper sheet to be made and is not a big problem for the recessed grooves 5s in the portions (S) outside the width of the paper sheet to be made.

In this respect, it is effective in view of both the performance of squeezing water and the strength of the belt that the depth (b') or the pitch (c') of the recessed grooves 5s in the portions (S) outside the width of paper sheet to be made is gradually changed toward the outside from the edge of the paper sheet to be made.

Further, the collapse and deformation of the recessed groove 5, the stress concentration at the bottom of the groove, the thickness of the resin layer under the groove and the like affect crack resistance. Therefore, as the ratio of the recessed grooves (depending on depth, width, pitch) to the belt having the same constitution and the same thickness is decreased, the strength thereof is increased but the performance of squeezing water is reduced. Accordingly, strength is thought important in the vicinity of the shoe edge which receives a concentrated load and the performance of squeezing water is thought important in the portion (U) inside the width of the paper sheet to be made.

Therefore, if both side end portions of the belt which are in the portions (S) outside the width of the paper sheet to be made in a pressing range have the following constitutions, the deformation of the grooves and the stress concentration caused thereby are reduced and the crack resistance can be improved in these portions.

1. The depth of the recessed grooves are made half of the depth of the recessed grooves in the portion inside the width of the paper sheet to be made.
2. The depth of the recessed grooves are made gradually shallower toward the outside from the vicinity of the edges of the wet paper sheet.
3. The pitch of the recessed grooves is made wider than the pitch of the recessed grooves in the portion inside the width of the paper sheet to be made.

If one or two of these countermeasures are adopted, the generation of cracks caused by the fatigue of the resin in the vicinity of the shoe edges is reduced or delayed, whereby the belt having the grooves can be used for a longer time.

#### Example Set 1

A resin layer 4 (thermosetting polyurethane) was formed on the inner surface, or shoe side, of a base cloth 2 made of polyester fiber and was ground to a predetermined thickness and roughness. A resin layer 3 (the same thermosetting polyurethane) was then formed on the outer surface, or felt side, of the base cloth and then was ground and finished to a predetermined thickness and roughness.

In one belt made as described, recessed grooves 5 were formed in the circumferential direction of the resin layer 3 on the felt side surface of the belt body 1. In this case, each recessed groove 5 was made 0.8 mm in width (a), 1.0 mm in depth (b), and 2.5 mm in pitch (c) (according to the conventional type, see FIG. 5).

In another belt made with inner and outer resin layers as described, the recessed groove 5u in the portion (U) inside the width of the paper sheet to be made was made 0.8 mm in width (a), 1.0 mm in depth (b), and 2.5 mm in pitch (c) and the recessed groove 5s in the portion (S) outside the width of the paper sheet to be made was made the same in width (a') and pitch (c') as the recessed groove 5u whereas the depth (b') of the recessed groove 5s was made 0.5 mm or half of the depth (b) of the recessed groove 5u (according to the present invention type 1, see FIG. 1).

In another belt made with inner and outer resin layers as described, the depth (b') of the recessed grooves 5s in the portions (S) outside the width of the paper sheet to be made were made gradually shallower while the depth (b) of the recessed grooves 5u in the portion (U) inside the width of the paper sheet to be made was made 1.0 mm, and the recessed groove was eliminated in the belt edge side (about 30 cm) (according to the present invention type 2, see FIG. 2).

In another belt made with inner and outer resin layers as described, the pitch (c') of the recessed grooves 5s in the portion (S) outside the width of the paper sheet to be made was made 5.0 mm, that is, the number of grooves per unit width was made 5/inch, while the pitch (c) of the recessed grooves 5s in the portion inside the width of the paper sheet to be made was made 2.5 mm, that is, the number of grooves per unit width was made 10/inch. In this case, the depth of the groove was made 1.0 mm and was common to all of them (according to the present invention type 3, see FIG. 3).

Still further, in another belt made with inner and outer resin layers as described, the pitch (c') of the recessed grooves 5s in the portion (S) outside the width of the paper sheet to be made was made the same as that of the above described present invention type 3 and the depth (b') thereof was made gradually shallower toward the outside (present invention type 4, see FIG. 4).

The time till the generation of a crack was measured by testing the crack resistance of both side ends of the belt hitting on the vicinity of the shoe edge in the above-described conventional type and the present invention types 1 to 4 using a bending machine made by the assignee of this invention to simulate actual useage of the belt and the results thereof are shown in TABLE 1.

TABLE 1

The present invention type 1	Cracks were generated after 350 hours
The present invention type 2	Cracks were generated after 350 hours
The present invention type 3	Cracks were generated after 380 hours
The present invention type 4	Cracks were generated after 380 hours
The conventional type	Cracks were generated after 250 hours

In the conventional type, fine cracks were generated in the bottom of the recessed grooves in the vicinity of the shoe edge in 250 hours after the test was started and grew rapidly along the recessed grooves to the base cloth.

On the other hand, in the present invention type 1, cracks were generated in the recessed grooves of the shoe edge portions and, in the present invention type 2, cracks were generated at the bottom of recessed grooves inside the shoe edge portions. The cracks of these types were the same level as those of the conventional type but the time when the cracks were generated was greatly delayed.

Further, cracks were observed in the recessed grooves in the shoe edge portions in the present invention type 3 and at the bottoms of the recessed grooves inside the shoe edge portions in the present invention type 4. The cracks generated in the present invention type 3 were small in number and shallow in depth in comparison with the conventional type and only fine cracks were generated in the present invention 4.

#### Example Set 2

A resin layer (thermosetting polyurethane) was formed on the inner or shoe side surface of a base cloth made of polyester fiber and was ground to a predetermined thickness and roughness, and then a resin layer (the same thermosetting polyurethane) was formed on the outer, or felt side, surface of the base cloth and was ground and finished to a predetermined thickness and roughness.

Recessed holes were formed in the circumferential direction of the resin layer on the felt side surface of the belt body. In one belt, each hole was made 2.0 mm in diameter, 2.0 mm in depth and 4.6 mm in pitch (interval of the adjacent holes) (according to the conventional type).

In another belt with inner and outer resin layers as described, the recessed hole in the portion inside the width of the paper sheet to be made was made 2.0 mm in diameter, 2.0 mm in depth, and 4.0 mm in pitch, and the recessed hole in the portion outside the width of the paper sheet to be made was made the same in diameter and pitch as the recessed hole in the portion inside the width of the paper sheet to be made but was made 1.0 mm in depth, which was half of the depth of the recessed hole in the portion within the width of the paper (according to the present invention type 1).

Then, the time until the generation of a crack was measured by testing the crack resistance of the both ends of the belt hitting on the vicinity of the shoe edge of the above-described conventional type and the present invention type using the above-described bending machine simulating actual useage. A crack was generated after 220 hours in the conventional type but no crack was observed until 350 hours in the present invention type.

As described above, according to the present invention, a belt for a shoe press having recessed grooves in a resin layer on the surface of the felt side of the belt body is characterized in that the depth of the grooves in the portion outside the width of the paper sheet to be made of the above described belt body is made shallower than the depth of the recessed grooves in the portion inside the width of the paper sheet to be made and hence the strength of the recessed groove in the vicinity of the shoe edge is increased, whereby crack resistance can be improved. That is, compared with the belt according to the conventional type, the deformation of the resin and stress concentration caused thereby are reduced and hence the generation of cracks is reduced or delayed, which produces the good effect of making the life of the belt longer.

Further, in the aspect of the invention in which the depth of the recessed groove in the portion outside the width of the paper sheet to be made is made about half of the depth of the recessed groove in the portion inside the width of the paper sheet, the recessed groove in the vicinity of the shoe edge is constituted such that the strength thereof is not reduced while keeping the performance of squeezing water and hence the generation of the cracks is reduced or delayed, which produces the good effect of making the life of the belt longer.

Further, in the aspect of the invention in which the depth of the recessed grooves in the portions outside the width of the paper sheet to be made is made gradually shallower toward the outside from the edges of the wet paper sheet, the belt at the belt side edges in which the required performance of squeezing water is little is constituted such that the

strength thereof is not reduced, which produces the good effect of satisfying both crack resistance and performance of squeezing water at the same time.

In addition, in the aspect of the invention in which the pitch of the recessed grooves in the portions of the above described belt body outside the width of the paper sheet to be made is made wider than the pitch of the recessed grooves in the portion inside the width of the paper sheet to be made, the number of the recessed grooves in the vicinity of the shoe edge is made smaller and hence the generation of cracks is reduced or delayed, which produces the good effect of making the life of the belt longer.

Preferred embodiments of the invention have been described in considerable detail. Many modifications and variations to the preferred embodiments described will be apparent to those skilled in the art. Therefore, the invention should not be limited to the embodiments described, but should be defined by the claims which follow.

#### Claims

1. In a belt for a shoe press having recessed grooves in a resin layer on a felt side surface of a belt body, the improvement wherein said recessed grooves in a portion of said belt body outside of a width of a paper sheet to be made are of a depth which is shallower than the depth of recessed grooves in a portion of said belt body which is inside of the width of said paper sheet.
2. The improvement of claim 1, wherein said depth of said recessed grooves in said portion of said belt body outside of said width of said paper sheet is about half of said depth of said recessed grooves in said portion inside said width of said paper sheet.
3. The improvement of claim 1, wherein said depth of said recessed grooves in said portion outside said width of said paper sheet becomes gradually shallower toward the outside from an edge of said paper sheet.
4. In a belt for a shoe press having recessed grooves in a resin layer on a felt side surface of a belt body, the improvement wherein a pitch of said recessed grooves in a portion of said belt body which is outside of the width of a paper sheet to be made is wider than a pitch of said recessed grooves in a portion of said belt body which is inside of the width of said paper sheet.

FIG. 1

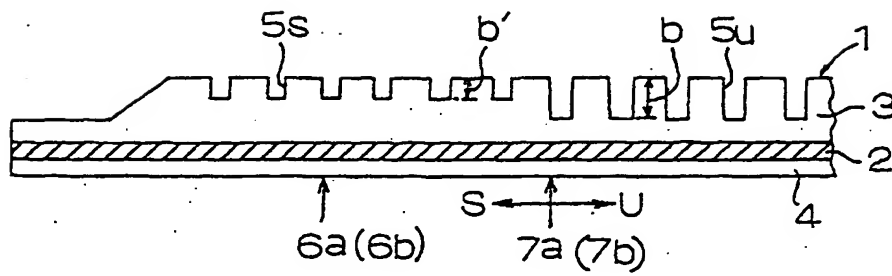


FIG. 2

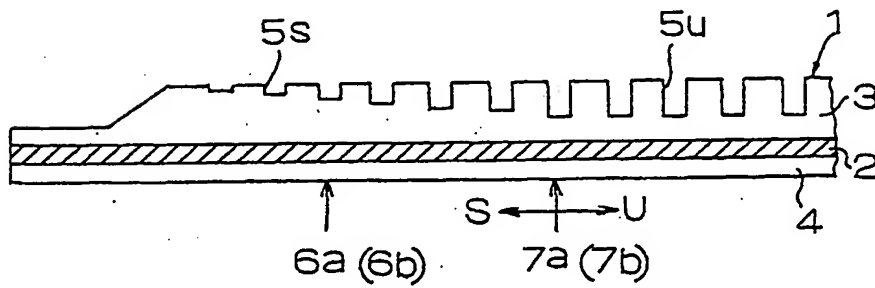


FIG. 3

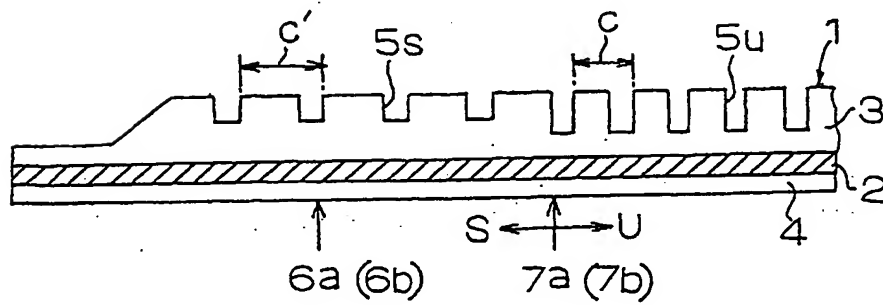


FIG. 4

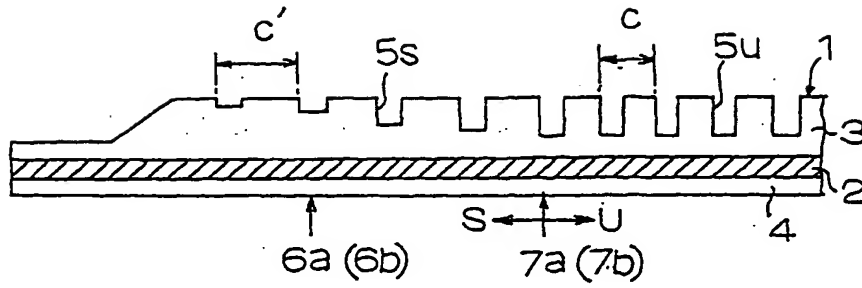


FIG. 5

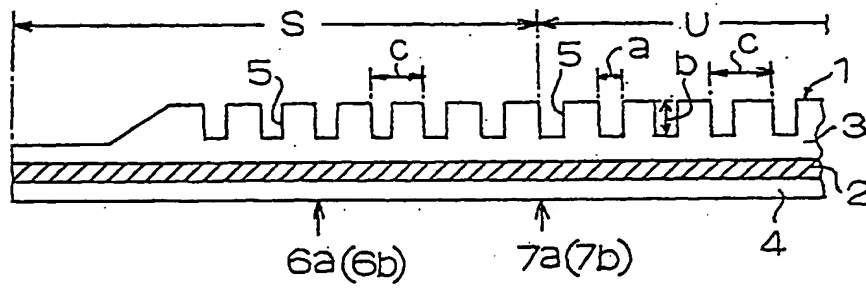
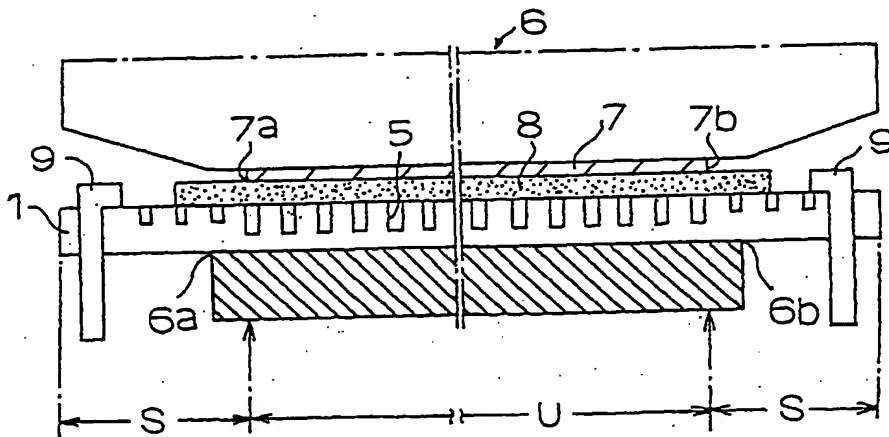


FIG. 6







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## EUROPEAN SEARCH REPORT

Application Number  
EP 98 11 0828

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	DE 44 45 472 A (VOITH SULZER PAPIERMASCHINEN) 27 June 1996 * the whole document *	1-4	D21F3/02
A	DE 44 11 621 A (VOITH SULZER PAPIERMASCHINEN) 5 October 1995 * the whole document *	1,3	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			D21F
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 9 October 1998	Examiner De Rijck, F
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